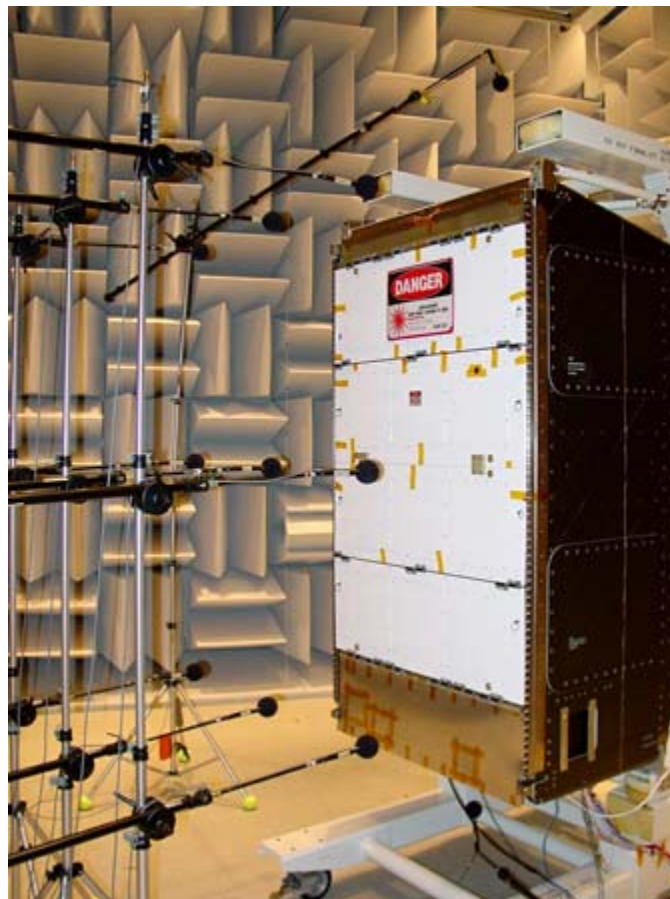


Fluids and Combustion Facility Acoustic Emissions Controlled by Aggressive Low-Noise Design Process

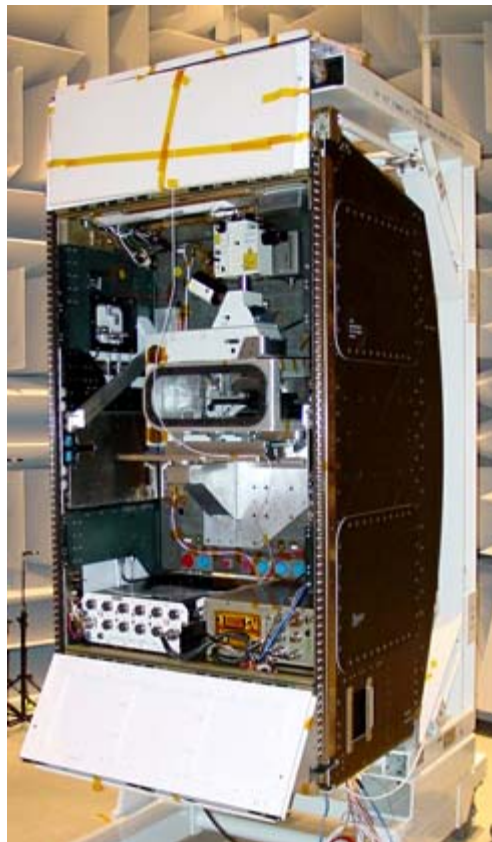
The Fluids and Combustion Facility (FCF) is a dual-rack microgravity research facility that is being developed by Northrop Grumman Information Technology (NGIT) for the International Space Station (ISS) at the NASA Glenn Research Center. As an on-orbit test bed, FCF will host a succession of experiments in fluid and combustion physics. The Fluids Integrated Rack (FIR) and the Combustion Integrated Rack (CIR) must meet ISS acoustic emission requirements (ref. 1), which support speech communication and hearing-loss-prevention goals for ISS crew. To meet these requirements, the NGIT acoustics team implemented an aggressive low-noise design effort that incorporated frequent acoustic emission testing for all internal noise sources, larger-scale systems, and fully integrated racks (ref. 2). Glenn's Acoustical Testing Laboratory (ref. 3) provided acoustical testing services (see the following photograph) as well as specialized acoustical engineering support as part of the low-noise design process (ref. 4).



FIR in Glenn's Acoustical Testing Laboratory with microphone array positioned for acoustic emission testing.

Acoustic emissions of the CIR and FIR were estimated using analytical models that incorporated results from testing at the source and systems level as well as transmission loss tests of the rack envelope. These initial estimates indicated that the cooling system was the dominant contributor to the total rack noise and predicted that noise levels of the fully integrated CIR and FIR would exceed ISS acoustic emission limits at high fan speeds. Integrated rack-level testing of the CIR and the FIR helped to improve the validity of the analytical models and refine the acoustic emission estimates.

The NGIT acoustics team developed a comprehensive noise-control plan for each rack that included replacement of selected noise sources with low-noise components, addition of transmission loss to the rack envelope, and installation of absorptive material where needed to bring the rack into compliance. The application of flat, white acoustically absorptive melamine foam to the side and rear panels of the rack, as well as to the rack doors and other selected areas is shown in the next photograph. A high-transmission-loss external "closeout" panel added below the door reduced the noise level to within a small margin of the requirement. Finally, the noise level was further reduced by operating the cooling system fans at lower speeds, while increasing water flow to meet thermal requirements.



Open FIR, shown with application of acoustically absorptive melamine foam on upper and lower door panels.

This aggressive low-noise design approach allowed both the CIR and FIR to meet the acoustic emission requirement at fan speeds that correspond to the design point for

cooling. The FCF noise-control plan calls for testing, before flying, all orbital replacement units expected to have significant noise emissions in order to maintain compliance with the ISS acoustic emissions requirements for the life of the FCF.

References

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Find out more about this research:

Glenn's Acoustic Testing Laboratory at <http://www.grc.nasa.gov/WWW/AcousticalTest/>

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